ELEMENTARY SCHOOL TRANSITION AND THE READING AND MATH ACHIEVEMENT OF STUDENTS WITH AUTISM SPECTRUM DISORDER, TRAUMATIC BRAIN INJURY, OR EMOTIONAL BEHAVIORAL DISTURBANCE

by

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Transition from elementary to middle or junior high schools has been associated with slowed reading and mathematics achievement for students in general education as well as students with disabilities. Little is known about how this transition affects students with autism spectrum disorder (ASD), traumatic brain injury (TBI), or emotional/behavioral disturbance (EBD). Reading and math scores from state achievement tests used for federal accountability reporting were analyzed from 125,646 Oregon students between 2006 and 2013. About half were female, about half qualified for free or reduced price lunch, and about 34% identified as an ethnic or racial minority. Piecewise longitudinal growth models were analyzed using hierarchical linear and nonlinear modeling, separately for reading and math achievement. Scores for all students, on average, rose slightly faster before transition than after transition. Students who experienced a school transition in Grade 6 were more negatively impacted than those who transitioned in Grade 7, while students who stayed in the same school from Grade 3 to 8 experienced the least impact. Initial scores in reading and math for students with ASD were lower than students without disabilities; students with EBD were lower still, and students with TBI had the lowest. Before transition, students with ASD and EBD accelerated faster in reading

than students without disabilities whereas in math, students with ASD or EBD showed improved scores immediately after transition. Students with EBD maintained post-transition trajectories similar to students without disabilities. Students with EBD had the most pronounced deceleration in reading scores after the transition whereas students with TBI had the most deceleration in math.

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INTRODUCTION

The transition from elementary to middle-grade schools has been associated with decelerating math and reading achievement growth for typically developing students (Alspaugh & Harting, 1995) and students with disabilities (Shin, Davison, Long, Chan, & Heistad, 2013). Less is known, however about the relationship between transition and achievement for students with specific disabilities. The current study examined differences in achievement growth trajectories before and after the transition from elementary school for students with autism, traumatic brain injury, or emotional/behavioral disorders.

Children experience many normative transitions in their school lives. Early transition occurrences include entering kindergarten and advancing to elementary school. Later, they might transition to middle or junior high school, high school, and on to college or to work. Particular interest in the association with the transition from elementary school self-contained classrooms to more departmentalized middle-grade schools (middle schools or junior high schools) peaked in the 1990s and early 2000s. Research from that time suggested that the rate of learning in math and reading slowed in middle school (Alspaugh, 1998; Alspaugh & Harting, 1995; Briggs & Weeks, 2009; Chung, Elias, & Schneider, 1998; Crockett, Petersen, Graber, Schulenberg, & Ebata, 1989; A. M. Ryan, Shim, & Makara, 2013) for typically developing students as well as students with learning disabilities (Anderman, 1998). Unfortunately, students whose achievement growth suffered the most after the middle school transition have been shown to be further hampered after their transition to high school (Alspaugh, 1998).

The discussion of why growth in both reading and mathematics slows as children age has not been well tested. Many researchers have proposed various possible explanations, though none have been strongly supported by research. The multiple possible explanations include personal or social/emotional explanations such as changes in human development or decreasing rate of growth in cognitive ability (J. Lee, 2010), declines in self-esteem or developmental mismatch between student and school (Seidman, Allen, Aber, Mitchell, & Feinman, 1994) or changes in self-perception or in their social lives (Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991). Some authors suggested academic content, such as the increasing complexity of the curriculum (J. Lee, 2010) or that earlier material is easier to acquire and later material is not only harder but builds on earlier learning and requires more sustained effort (Shin et al., 2013). Methodological components such as test construction, ceiling effects or regression to the mean may explain some of the decline (S. Lee, Wehmeyer, Palmer, Soukup, & Little, 2008). Lastly, school structures, such as stricter evaluative practices (Blyth, Simmons, & Carlton-Ford, 1983; Schulenberg, Asp, & Petersen, 1984) or the perception of daily hassles with school (Seidman et al., 1994) may be responsible for the decline. Although all of the above appear plausible, none have yet shown strong causal evidence for their role in the reduced achievement over time.

The decelerating achievement after the elementary school transition combined with evidence of less severe academic declines for students in stable school environments (Rudolph, Lambert, Clark, & Kurlakowsky, 2001) prompted some researchers to call for restructured middle schools (Seidman et al., 1994) or K-8 schools (Juvonen, 2007;

Kieffer, 2013) as more developmentally appropriate alternatives to traditional middle schools.

Challenges children face after leaving elementary school are not limited to slowing academic achievement. Additional problems after transition have been noted relating to self image (Crockett et al., 1989), self esteem (Wigfield et al., 1991), psychological distress (Chung et al., 1998; Elias, Gara, & Ubriaco, 1985), anxiety (Grills-Taquechel, Norton, & Ollendick, 2010), depression (Rudolph et al., 2001), aggression (Vanlede, Little, & Card, 2006), discipline problems (Cook, MacCoun, Muschkin, & Vigdor, 2008; Theriot & Dupper, 2010), and even a sense of hope for the future (Tsuzuki, 2012). Many of these issues can affect children's' feelings of competence and can contribute to difficulties relating to peers and adults.

The problems associated with transitioning to middle school prompted Eccles and Midgley (1989) to develop their stage-environment fit model to guide research on the middle school transition. That model relied on self-determination theory (Ryan & Deci, 2001) as a main building block. Indeed, self-determination theory provides a useful framework for understanding many of the issues students face during the transition to middle grades schools and has been shown to be associated with both reading and math achievement for students with learning disabilities and emotional/behavioral disturbances (Deci, Hodges, Pierson, & Tomassone, 1992). Self-determination theory (SDT) is organized around three underlying fundamental psychological needs: autonomy, competence, and relatedness. Those three psychological needs are linked to individual motivation and academic self-efficacy, which have been associated with academic performance and grades (Solberg, Howard, Gresham, & Carter, 2012). In SDT, autonomy refers to the person's perception of being the initiator of his or her behavior. Therefore, the adolescent desire for greater independence relates to the psychological need for autonomy, which is heightened during the transition from elementary to middle or junior high schools. The second psychological need in SDT is competence, which can be described as the confident feeling or belief in one's effectiveness. Competence allows students to seek and persistently pursue challenges that demonstrate their capacities. Success in academic achievement can increase students' feelings of competence. Finally, relatedness, the third psychological need is the feeling of connection with others. Caring for others and being cared for can lead to a sense of belonging and being part of a community. The departmentalized nature of middle and junior high schools can be seen as less of a community than the self-contained classrooms of elementary school. Thus, the adolescent period is a time when the three needs delineated by SDT are developing or expanding. Children are growing in their competence and able to tackle and accomplish more challenging tasks; through their successes they can have a more developed sense of autonomy; and their social relationships and their place in the community are changing and developing rapidly. So although middle schools can be seen as a time of great change and opportunity for developing or enhancing the individual's sense of autonomy, competence, and relatedness, the structure of many middle and junior high schools minimizes the flexibility growing adolescents need to fully integrate their emerging selves (Eccles, Lord, & Midgley, 1991). To frame it more positively, numerous studies have identified the academic benefits for autonomously-motivated students (Lord, Eccles, & McCarthy, 1994; Reeve, 2002).

Well-studied constructs such as reading and math achievement scores have the potential to provide meaningful insight about student growth before and after the middle grades school transition. Unfortunately, of the studies measuring longitudinal growth in reading achievement, results about growth trajectories have not been consistent. For example, the gap between successful and struggling readers has been shown to widen (sometimes referred to as the Matthew effect; Bast & Reitsma, 1998), remain constant (Catts, Bridges, Little, & Tomblin, 2008; Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996), or to decrease (Leppnen, Niemi, Aunola, & Nurmi, 2004; Shin et al., 2013; Skibbe et al., 2008).

A similar situation exists for research on math achievement. Research on achievement growth for math has found similar discrepancies in results as the studies on reading. Growth has been associated with widening (e.g. Bodovski & Farkas, 2007), decreasing (e.g. Seltzer, Choi, & Thum, 2003), and parallel (e.g. McClelland, Acock, & Morrison, 2006) achievement growth gaps among groups depending on independent variables being modeled, dependent variable measurement, or methodological differences.

The achievement gap between students with or without disabilities (as well as other subgroups) has been a growing concern. The No Child Left Behind Act (NCLB, 2002) required states to identify grade-level proficiency standards that all students were expected to meet, regardless of disability, minority, or other subgroup status. Annual evaluation procedures identified schools that met required adequate yearly progress (AYP) goals. The questions that remain unanswered for students with disabilities is whether they enter school with lower scores than their peers, if the achievement gap develops or changes over time, or both.

The literature on achievement growth for reading and math for elementary and middle school students has focused primarily on students without disabilities (SWoDs). Much less attention has been given to students with disabilities SWDs. The studies that have considered students with disabilities have mostly focused on the most prevalent of those, such as specific learning disabilities (LD). For example, in both reading and math, children with LD, speech language impairment (SLI), ASD, attention deficit/hyperactivity disorder (ADHD), or developmental delay (DD) have consistently shown lower initial scores in early elementary grades (Bussing et al., 2012; Carlson, Jenkins, Bitterman, Keller, & National Center for Special Education, 2011; Judge & Watson, 2011; Morgan, Farkas, & Wu, 2011; Sanford, Park, & Baker, 2013; Schulte, Villwock, Whichard, & Stallings, 2001). That gap in math has been shown to increase for students with LD and remain constant for students with DD. In contrast, students with ASD have been shown to reduce the gap compared to students with SLI or DD (Carlson et al., 2011). In reading, students with language impairment achieved growth rates lower (Morgan et al., 2011) or the same (Catts et al., 2008) as students without disabilities.

Although some studies have included students from each Individuals with Disabilities Education Improvement Act classification category (Wei, Blackorby, & Schiller, 2011; Wei, Lenz, & Blackorby, 2013), few studies have focused on some of the less-prevalent disabilities.

Very little research has been published about the reading and math achievement growth, for example, of students with specific disabilities such as autism spectrum disorder (ASD), traumatic brain injury (TBI), or emotional/behavioral disabilities (EBD). Students affected by these three disabilities share some common challenges as can be seen from their qualifying descriptions in the IDEA. All three disabilities in children can affect interpersonal skills with teachers and peers, inappropriate or unpredictable behavior, atypical sensory responses or physical symptoms, and a decreased ability to learn. Therefore, because of the lack of previous achievement research for these three disabilities, the similarities of challenges at school, and the need for in-depth information about achievement growth for these students, this study focused on students with ASD, TBI, or EBD.

Ideally, more information about growth trajectories for students from every disability category would have been included in the present research. Unfortunately, various limitations precluded their inclusion in this study. Too few students with developmental delay (a category that is now limited to the maximum age of 9) or deaf-blindness were available in the Oregon data. Students from the categories of speech or language impairments, visual or hearing impairments, multiple disabilities, specific learning disabilities, or intellectual disability have many challenges that are different than the unpredictable behavior, atypical sensory responses, or challenges with interpersonal skills that characterize students with ASD, TBI, or EBD. The categories of other health impaired and orthopedic disabilities are comprised of broad arrays of physical or health impairments with no means for disentangling aggregate results to provide meaningful interpretation. Inclusion of students with ADHD would have provided an interesting comparison group. However, because ADHD is not a recognized category under IDEA, there was no way to identify those children in the educational data.

Students with Autism Spectrum Disorder

Classification for special education under any category is based on the Oregon Administrative Rules for Special Education (2013). The criteria for students to be eligible for special education under the ASD classification include impairments in communication and social interaction; patterns of behavior, interests or activities that are restricted, repetitive, or stereotypic; and unusual responses to sensory experiences. Each of those characteristics must be present, inconsistent with the child's development in other areas, documenting presence over time or showing level of intensity.

There is much agreement that the academic achievement and intelligence of children with autism are characterized by considerable heterogeneity (Estes, Rivera, Bryan, Cali, & Dawson, 2011; Griswold, Barnhill, Myles, Hagiwara, & Simpson, 2002; Jones et al., 2009; Nation, Clarke, Wright, & Williams, 2006). Such high variability in achievement measures can obscure research conclusions. For example, a group mean score for a math achievement measure may hide the existence of subgroups of students with very low or with very high scores. Several strategies have been used to clarify the heterogeneous nature of students with ASD. Jones and colleagues (2009) identified four groups of students with ASD whose observed reading and arithmetic scores were higher and/or lower than would be expected based on their IQ. Other researchers have analyzed achievement in relation to IQ (Eaves & Ho, 1997; Estes et al., 2011; Mayes & Calhoun, 2003b) or comprehension ability (Nation et al., 2006).

In general, studies on achievement for students with ASD have found conflicting results showing that they may have poor, average, or advanced word decoding skills (Jones et al., 2009; Minshew, Goldstein, Taylor, & Siegel, 1994; Myles, Barnhill, Hagiwara, Griswold, & Simpson, 2001; Nation et al., 2006; Newman et al., 2007), poor or average reading comprehension skills (Jones et al., 2009; Minshew et al., 1994; Myles et al., 2001; Newman et al., 2007), and poor, average, or advanced math skills (Chiang & Lin, 2007; Jones et al., 2009; Mayes & Calhoun, 2003a; Minshew et al., 1994) than would be expected by their IQ. The number of studies reaching different conclusions underscores the issue that autism is characterized by tremendous heterogeneity (Griswold et al., 2002). Those mixed results also illustrate the need for describing achievement over time.

Very few studies have examined the longitudinal growth of achievement in reading and math for students with ASD. Those that did have mostly confirmed what has been found through the cross-sectional studies. For example, Estes (2011) demonstrated that a discrepancy from expected scores exists for both word reading and basic number skills and confirmed that children with ASD exhibit wide variability in achievement. Additionally, quadratic growth curves tend to best represent achievement over time for students with ASD, just as in the typical population (Carlson et al., 2011; Wei et al., 2011; Wei et al., 2013). Furthermore, in comparison to students with learning disabilities, students with ASD scored lower in reading and they did not catch up over time (Wei et al., 2011). For math, one study showed children with ASD had lower skills than children with speech/language impairment at age 3 but did close the gap by age 10 (Carlson et al., 2011). However, students with ASD had applied math problem scores significantly lower than students with TBI or EBD and calculation scores lower than students with learning disabilities (Wei et al., 2013). A recent study found that math scores were initially lower than SWoDs and performance did not keep up over time (Stevens, Schulte, Elliott, Nese,

& Tindal, 2014). The lack of knowledge about achievement for students with ASD, especially the longitudinal growth in reading and math, presents a challenge for educators to understand the educational needs of children with ASD.

Students with Traumatic Brain Injury

To be classified as a student with TBI, the child a) must have an acquired injury to the brain caused by an external physical force; b) must have a condition considered permanent or expected to last for more than 60 days; c) have an injury that results in an impairment in communication, behavior, cognition, memory, attention, abstract thinking, judgment, problem solving, reasoning or information processing; or sensory, perceptual, motor, and/or physical abilities. In addition, the child's disability must have an adverse impact on educational performance and she/he must need special education services as a result of the disability.

In general, students with TBI perform similar to or lower than students with learning disabilities in reading comprehension, word identification, and mathematics in both initial scores, growth, and acceleration patterns (Wei et al., 2011; Wei et al., 2013). Much of the research on academic achievement for students with TBI has attempted to explain group differences by either the age at which the injury occurred or the severity of the injury (see (Taylor & Alden, 1997) for a discussion of age-related effects of TBI). Unfortunately, the age definitions and the criteria used to determine severity have been inconsistent throughout the literature. Even so, there is little research about students with TBI that does not include age at injury or severity as primary predictor variables or as control variables in analyses of other factors.

Cross-sectional studies for reading achievement have shown that early age at injury was associated with poorer overall achievement (Catroppa et al., 2009; Ewing-Cobbs et al., 2006; Lajiness-O'Neill, Erdodi, & Bigler, 2011) as well as lower scores in specific areas of achievement such as complex reading skills (Hanten et al., 2009), reading fluency (Ewing-Cobbs et al., 2006), and decoding skills (Barnes, Dennis, & Wilkinson, 1999). The effects of severity of injury have been less consistent in predicting reading outcomes. For example, severity has been shown to be ineffective at predicting reading in general (Arroyos-Jurado, Paulsen, Merrell, Lindgren, & Max, 2000; Kinsella et al., 1995) yet in other studies, comprehension (Ewing-Cobbs et al., 2004), fluency (Ewing-Cobbs et al., 2006), and expressive language (Hanten et al., 2009) were negatively affected. Adding to the confusion, severity displayed mixed results for reading accuracy (Catroppa & Anderson, 1999, 2007; Catroppa et al., 2009) and achievement (Arroyos-Jurado et al., 2000). Some of the inconsistency among studies may be related to the interaction of age at injury and severity. For example, Catroppa (2009) found that increased severity negatively affected reading for children injured at a younger age but not those injured later. Another reason for differing results for both reading and math is the high variability in deficits known for students with TBI (Chapman et al., 2001).

Evidence suggests that TBI affects math and arithmetic achievement in general even more than reading (Catroppa, Anderson, Morse, Haritou, & Rosenfeld, 2008; Goldstein & Levin, 1985). However, unlike reading, age at injury does not consistently predict math achievement. Being injured at a younger age has been associated with lower (Fulton, Yeates, Taylor, Walz, & Wade, 2012), higher (Ewing-Cobbs et al., 2004; Fulton, Yeates, Taylor, Walz, & Wade, 2012), or similar (Catroppa et al., 2009; Lajiness-O'Neill et al., 2011) math achievement scores compared to students injured later in childhood. On the contrary, severity of injury has shown a more consistent dose-response relationship with math achievement showing children with the most severe injuries score lower than non-TBI comparison groups or to students with mild and/or moderate brain injuries (Berger-Gross & Shackelford, 1985; Catroppa & Anderson, 1999, 2007; Catroppa et al., 2009; Ewing-Cobbs et al., 2004; Ewing-Cobbs et al., 2006; Fulton et al., 2012).

Very few studies assessed reading longitudinally for students with TBI. Generally, students with TBI had reading growth and acceleration trajectories similar to students with learning disabilities, albeit a bit lower (Wei et al., 2011). Additionally, children regain many cognitive skills more rapidly at first, then recovery slows dramatically (Jaffe, Polissar, Fay, & Liao, 1995). For students injured younger, studies examining reading growth have found they initially gained at a more rapid rate than students injured at an older age but had overall poorer achievement (Hanten et al., 2009) or that their growth slowed in comparison to those injured later for reading recognition (Ewing-Cobbs et al., 2004). The evidence suggests that both age at injury and severity negatively impact achievement and severe injuries more adversely affect those injured at a younger age.

Longitudinal studies of mathematics achievement are few. However, Wei (2013) found patterns for mathematics similar to reading. That is, both growth and acceleration for students with TBI were similar to students with learning disabilities. Also, similar to studies on reading, younger age at injury was associated with lower growth (Ewing-Cobbs et al., 2004). Longitudinally, children who were more severely injured had persistently lower math scores than those with milder injuries (Catroppa et al., 2009; Ewing-Cobbs et al., 2004; Jaffe et al., 1995).

As with students with EBD, there is an association of ongoing behavioral problems and academic performance for students with TBI (Hawley, 2004). Behavioral problems may appear immediately or years after the injury and may worsen over time (Li & Liu, 2013). Indeed, more severe behavior problems have been linked with poor academic outcomes (Hawley, 2004) in students with TBI. Behavioral problems in combination with impaired academic abilities present significant challenges for teachers of children with TBI. It has been suggested that unless they have known someone with TBI or have previously taught a child with TBI, teachers may be ill-prepared to overcome those challenges (Miller & Donders, 2003).

Students with Emotional Behavioral Disturbance

Eligibility criteria for EBD include exhibiting a) an inability to learn that cannot be explained by intellectual, sensory, or health factors; b) inability to build or maintain interpersonal relationships; c) inappropriate behaviors or feelings under normal circumstances; d) general pervasive mood of unhappiness or depression; or e) a tendency to develop physical symptoms or fears associated with personal or school problems.

Whereas achievement studies on children with TBI have focused on grouping by age at injury or severity and research on autism tended to delineate based on IQ or other abilities, studies of achievement for students with EBD by grouping variables has been less consistent. For example, studies have considered achievement outcomes in relation to presence of learning disability (Mattison, Hooper, & Glassberg, 2002), externalizing problems (Nelson, Benner, Lane, & Smith, 2004), age (Nelson et al., 2004), whether served in self-contained classrooms or self-contained schools (Lane, Wehby, Little, & Cooley, 2005), underlying problems (Mattison, 2008), presence of language disorders (Benner, Mattison, Nelson, & Ralston, 2009), or considered as a homogenous group (Wei et al., 2013). Although not uniformly defined, each way of grouping children has revealed different ways of understanding their academic achievement challenges.

The numerous studies and literature reviews that address academic outcomes for children with EBD do provide insights about the challenges those students face. Students with EBD in general perform below their typically developing peers in reading and math (Gronna, Jenkins, & Chin-Chance, 1998), by as much as two grade levels in one study (Wagner, 1995). In fact, many reports found little or no difference between academic outcomes for children with EBD and those with learning disabilities (Gage, Lierheimer, & Goran, 2012; Goran & Gage, 2011; Lane, Carter, Pierson, & Glaeser, 2006; Sabornie, Cullinan, Osborne, & Brock, 2005; Trout, Nordness, Pierce, & Epstein, 2003; Wei et al., 2013). Furthermore, as Mattison (2002) pointed out, students with EBD may or may not also have a learning disability (LD) and those with comorbid LD performed significantly worse on both reading and math outcomes than students without LD. The deficits in reading achievement have been shown to be associated with challenges due to various underlying conditions including phonological processing, comprehension (or both) (Mattison, 2008), language disorders (Benner et al., 2009), or vocabulary (Coutinho, 1986; Goran & Gage, 2011). Achievement in math appears to be more problematic than reading for students with EBD (Anderson, Kutash, & Duchnowski, 2001; Gronna et al., 1998; Lopez, 1996; Reid, Gonzalez, Nordness, Trout, & Epstein, 2004) and math problems are likely to be more severe for older students (Gronna et al., 1998).

The small number of longitudinal studies of achievement that included students with EBD compared them to either students without disabilities (Gronna et al., 1998; Stevens et al., 2014) or students with learning disabilities (Anderson et al., 2001; Wei et al., 2013). Although students with EBD have been shown to have lower reading scores compared to typically developing students, that gap narrowed between Grades 3 and 6 then maintained between Grades 6 and 8 (Gronna et al., 1998). However, compared to students with LD, students with EBD have been shown to have higher reading scores but either lower (Anderson et al., 2001) or similar (Wei et al., 2011) growth. For math, students with EBD had lower scores than non-disabled students but had either faster (Gronna et al., 1998) or slower growth (Wei et al., 2013). Still, students with EBD and those with LD had similar scores and growth patterns (Anderson et al., 2001; Wei et al., 2013). Overall, students with EBD tend to perform below their non-disabled peers and similar to students with LD. Whether they catch up over time in either reading or math is unclear.

In considering the disability categories of TBI, ASD, and EBD, similarities and differences can be noted. Achievement outcomes for children with ASD and TBI have been described as highly variable but EBD appears to be less so. Generally, compared to non-disabled students, children with TBI have lower scores for both reading and math, and their growth trajectories seem to be better, similar, or worse, depending on severity and the age at injury. Students with ASD have widely varying scores on reading and math, ranging from poor to advanced in numerous studies. Over time, these students tend to catch up in math, but not in reading. For students with EBD, both reading and math scores have been found to be lower than non-disabled peers and similar to students with

LD with math presenting more of a problem than reading. Longitudinal studies for both math and reading conflict by showing either higher or lower gains over time.

Although some studies, albeit with conflicting results, have examined achievement or growth for students with TBI, ASD, or EBD, the specific patterns of growth over the transition to middle or junior high school have not been explored. In order to investigate the achievement growth of students with TBI, ASD, or EBD before and after the transition from elementary school, the research questions for this study were: (a) what are the mathematics and reading achievement growth trajectories in Grades 3 through 8 for students with ASD, TBI, or EBD; (b) how do the trajectories within each disability category differ from elementary to middle or junior high school; and (c) how do the reading and math achievement growth trajectories of students with these disability classifications compare to SWoDs?

CHAPTER II

METHOD

Participants

Achievement in mathematics and reading were examined using data collected from Oregon public school students who participated in the Oregon Assessments of Knowledge and Skills (OAKS) annual testing in grades three through eight between 2007 and 2013. The OAKS is unusual in that up to three test administrations per student are allowed between November and May of each school year. The student scores analyzed here were the best score obtained that was used for operational accountability reporting.

Five years of data were analyzed for Cohort 1 who began Grade 4 in 2007/08 and completed Grade 8 in 2011/12 so no Grade 3 data were analyzed for this cohort (see Table 1). Cohort 2 began Grade 3 in 2007/08 and completed Grade 8 in 2012/13. Cohort 3 began Grade 3 in 2008/09 and completed Grade 7 in 2012/13.. The multiple-cohort design (sometimes referred to as an accelerated longitudinal design) strengthens the analysis in multiple ways. Not only is sample size increased, combined cohorts present better representations over time and show greater average stability than single cohorts. In addition, subject age and historical effects are less confounded than in a single cohort design and sample attrition can be reduced (Miyazaki & Raudenbush, 2000).

Table 1
Three Cohorts and the Associated Grade Levels During Each School Year

	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Cohort 1	4	5	6	7	8	
Cohort 2	3	4	5	6	7	8
Cohort 3		3	4	5	6	7

However, cohort designs might present problems if the cohorts differ systematically from each other in meaningful ways. Contingency tables and *z*-tests showed that some statistically significant differences in demographic characteristics existed among cohort groups as shown in Table 2. In this sample, the largest difference between cohorts for any demographic variable was for FRL, which had a very small effect size (h = .098). Cohort 1 had the fewest males, FRL students, and SWD, but the highest number of minority students. Cohort 3 had the most males, FRL students, and SWD but the fewest minority students. The largest difference between cohorts was FRL between Cohort 2 and 3 (2.1%). For the outcome measures, mean group differences were very small. Average score differences for math were .49 and for reading, .33 across all years. Because the differences among cohorts were so small, the cohorts were combined to represent a single group with six measurement occasions from Grade 3 to 8.

Table 2

Comparison of Sex, Minority Status, Qualification for Free or Reduced Price Lunch, and Disability Category by Cohort.

	Male		Minority		FRL		Disability	
Cohort	n	%	n	%	N	%	n	%
1	19432	48.4	14132	35.2	19570	48.8	827	2.1
2	20568	48.8	14765	35.0	20505	48.6	1106	2.6
3	21460	49.5	15112	34.9	21980	50.7	1341	3.1
Total	61442	48.9	44009	35.0	62083	49.4	3274	2.6
z	222.03		53.68		997.41		130.5	
h	0.022		0.006		0.098		0.063	

Note: FRL = Free/reduced price lunch. Based on largest difference, which was between Cohorts 1 and 3 for each variable except FRL, which was between Cohorts 2 and 3.

All Oregon schools supplied demographic information to the state department of education, which entered it into a database that was returned to the schools for verification. Schools reported students classified as having TBI, ASD, or EBD based on the state eligibility criteria in use at the time of each assessment.

Along with increasing numbers of SWDs, the sample showed multiple changes in classification during the study duration. Although some students moved categories several times, most remained relatively stable. The percentages of students categorized as having ASD, TBI, or EBD for at least half of their measurement occasions were 89%, 83%, and 83% respectively. Visual inspection of the data showed that most frequently students moved from no disability code to EBD, TBI, or ASD, or less often, from a more general disability such as “other health impairment” to one of the three. Although students who have always been in special education have been shown to have lower scores and slower growth than SWoDs, having ever been in special education is similarly associated, albeit less so (Schulte & Stevens, 2015). All students in this sample had scores for one to six measurement occasions. For this study, students were considered to have a disability if they had the ASD, TBI, or EBD code at least 33.3% of the measurement occasions for which they had data, thereby not including students who had just one out of five or six measures. So if they had data for only two occasions, and at one they were listed as TBI and the other they were listed as no disability, they were coded as having a TBI. When there was more than one code, the assignment of disability was based on the code listed most frequently. In the few cases that had equal numbers of two disability codes, the code closest to Grade 6 was used. This coding allowed inclusion of most students who had ever been in special education. In addition, assigning disability category based on the most frequent placement rather than first placement took into consideration placement over time.

Although about half the school population was female, males were overrepresented in each disability category, especially ASD (87.3% male), as can be seen in Table 3. About half the entire sample (but about two thirds of the TBI and EBD disability categories) qualified for free or reduced lunch (an indicator of lower socio-economic status). Slightly fewer minority students had ASD compared to TBI or EBD.

Most Oregon children in Grades 3 through 8 attend schools that are structured as elementary schools that transition students to more compartmentalized middle schools or junior high schools in either 6^{th} (14.3% of all Oregon schools) or 7^{th} (7.9% of schools) grades. In addition, some schools continued the self-contained classrooms of elementary education through 8^{th} grade (29.7% of Oregon schools). However, most of the students transitioned into middle schools in 6^{th} grade (65.9%). The remainder of students transitioned in either 7^{th} grade (22.7%) or had no transition through 8^{th} grade (11.4%) as shown in Table 4. This variety of school structures allowed the examination of the trajectories across three different transition times.

Measures

State summative assessments in mathematics and reading/literature were administered annually beginning in Grade 3. The Oregon Assessments of Knowledge and Skills (OAKS) are computer-adaptive, multiple-choice assessments aligned to grade-level academic content standards, vertically linked, and used for state and national accountability reporting. OAKS testing is normally completed online between November and May of each academic year. Students who took alternate assessments (generally, students with severe disabilities) were excluded from the analyses due to the lack of correspondence between the regular and alternate assessments. Adaptive computer testing

Table 3

Sex, FRL, and Minority Status of Sample by Disability Category (N = 122,372)

	n	%	*z*	*h*
Group		Sex (male)		
SWoDs	58753	(48.00)		
ASD	1555	(87.30)	3061.70	-0.88
TBI	36	(62.10)	169.28	-0.28
EBD	1116	(77.80)	1973.97	-0.63
		FRL		
SWoDs	60145	(49.10)		
ASD	845	(47.40)	98.16	0.03
TBI	40	(69.00)	251.67	-0.41
EBD	1025	(71.40)	1416.11	-0.46
		Minority		
SWoDs	43206	(35.30)		
ASD	379	(21.30)	567.82	0.31
TBI	19	(32.80)	22.80	0.05
EBD	405	(28.20)	313.53	0.15

Note. FRL = qualified for free or reduced price lunch. SWoDs = students with no disability designation; ASD = Autism Spectrum Disorder; TBI = Traumatic Brain Injury; EBD = Emotional/Behavioral Disturbance.

Table 4

Number and Percent of Students' Grade of Transition from Elementary School by Disability Category (n = 125,646)

	No transition		Grade 6		Grade 7	
	n	(%)	*n*	(%)	*n*	(%)
SWoDs	13,811	(11.3)	80,713	(66.0)	27,848	(22.8)
ASD	244	(13.7)	1193	(67.0)	344	(19.3)
TBI	5	(8.6)	43	(74.1)	10	(17.2)
EBD	286	(19.9)	863	(60.1)	286	(19.9)
Total	14,346	(11.4)	82,812	(65.9)	28,488	(22.7)

provides students with the appropriate difficulty level of items based on their performance on items administered earlier. Rasch Unit (RIT) scale scores for the OAKS mathematics and reading assessments from students in Grades three through eight served as the two longitudinal outcome variables. The RIT scales range from 150 to 300, have a mean of 200, and a standard deviation of 10 for every test administration. Proficiency categories were established to meet the reporting requirements of the No Child Left

Behind Act of 2001 and provide a mechanism to determine whether each school has made adequate yearly progress (AYP). For example, for Grade 3 math, the "Meets" proficiency category ranges from 205 to 216. The cut scores provide benchmarks for individual or group comparisons.

The vertical linking of OAKS allows comparison of scores over time on the same scale. Psychometric properties of the OAKS include high reliability and validity (content, concurrent, and criterion) and are described in detail in a series of technical reports available on the Oregon Department of Education website (http://www.ode.state.or.us/search/page/?=1305). For reliability, standard error of measurement curves indicated that for students with scores between the 10^{th} and 90^{th} percentiles, the standard error of measurement was about three RIT scale score points. Except for students in the 99^{th} percentile, similar information was provided throughout the range of proficiencies. Concurrent validity correlations for OAKS and (a) the California Achievement Test for reading ranged from .75 to .80 and math from .74 to .80; (b) the Iowa Test of Basic Skills reading ranged from .78 to .84 and math from .76 to .85; and (c) the Northwest Evaluation Association subject tests in reading ranged from .73 to .82 and math from .66 to .84 (ODE, 2007).

Demographics

Table 5 displays the percentages of students' sex, minority status, and qualification for FRL for each transition type.

Table 5
Percentages of Demographic Characteristics by Transition Type and Disability Category

Transition	Disability	% Male	% White	% FRL
No Transition	SWoDs	48.0	69.3	45.5
	EBD	87.3	73.8	43.4
	TBI	40.0	80.0	60.0
	ASD	78.7	63.6	67.5
Grade 6	SWoDs	47.8	62.9	50.1
	EBD	87.4	78.7	49.6
	TBI	65.1	67.4	67.4
	ASD	78.2	70.7	72.5
Grade 7	SWoDs	48.7	67.7	48.4
	EBD	86.9	82.3	42.7
	TBI	60.0	60.0	80.0
	ASD	75.5	83.2	73.8
Overall		48.9	65.0	49.4

Note. ASD = Autism Spectrum Disorder; TBI = Traumatic Brain Injury; EBD = Emotional Behavioral Disturbance; FRL = qualifies for free or reduced lunch.

Analysis

Descriptive analyses were computed in SPSS Version 21 (2012). Growth models were analyzed using HLM 7 (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011).Variables used in the analyses included reading and math scores for six years of OAKS data; dummy coded control variables for sex, ethnicity, and qualification for free or reduced price lunch (FRL); grade of transition; and disability category. Disability category was specified as a dichotomous variable for each category (TBI, ASD, or EBD) with having the disability coded as 1, otherwise, 0. The SWoDs were the reference group.

A sequential process was used to build multilevel, analytic models beginning with a fully unconditional model. The next models examined the specification of measurement occasions at level 1. Separate models were run comparing time structured as either a linear or a quadratic function of time. Because of the specific research interest in changes in student performance during school transition, additional piecewise, multilevel models were applied to model transition relationships. In these models, time of transition was incorporated into the coding of the level-1 piecewise time code such that only students who transitioned at Grade 6 received the modeled changes of Grade 6 transition and likewise for Grade 7 as illustrated in Table 6. Students who did not transition had "0" for changes in intercept and slope. No interactions were tested.

Table 6
Coding of Transition Time for HLM Analysis

Transition Type	Linear	Quadratic	Piecewise change in intercept	Piecewise change in slope
None	0 1 2 3 4 5	0 1 4 9 16 25	0 0 0 0 0 0	0 0 0 0 0 0
Grade 6 transition	0 1 2 3 4 5	0 1 4 9 16 25	0 0 0 1 1 1	0 0 0 0 1 2
Grade 7 transition	0 1 2 3 4 5	0 1 4 9 16 25	0 0 0 0 1 1	0 0 0 0 0 1

The research questions for this study focused on the relationships of type of disability and type of transition with achievement in math and reading. However, the associations of sex, ethnicity, and FRL were included to allow estimation of the relationships of disability and transition after background variables were taken into account. Although it is likely that school or regional relationships may also influence achievement scores, the focus of this study was on the specific relationships of the type of transition on individual student growth.

Growth was modeled as a two-level hierarchical linear model separately for reading and math. In all analyses, model parameters were specified as random effects.

First, an unconditional model was fit using annual achievement scores for students in Grades 3 through 8 at level 1 and students at level 2. The specification of the unconditional model was

Level-1 Model

$$SCORE_{ti} = \pi_{0i} + e_{ti}$$

Level-2 Model

$$\pi_{0i} = \beta_{00} + r_{0i}$$

Three models representing alternative functions of scores over measurement occasions, linear, quadratic, and piecewise models were then fit. The covariates, sex, ethnicity, and FRL were then added at level 2, followed by a final model which also added three dummy coded predictors of student exceptionality group. The final quadratic model was:

Level-1 Model

$$SCORE_{ti} = \pi_{0i} + \pi_{1i}*(LinearTime) + \pi_{2i}*(QuadraticTime) + e_{ti}$$

Level-2 Model

$$\pi_{0i} = \beta_{00} + \beta_{01}*(SEX_i) + \beta_{02}*(ETH_i) + \beta_{03}*(FRL_i) + \beta_{04}*(ASD_i) + \beta_{05}*(TBI_i) + \beta_{06}*(EBD_i) + r_{0i}$$

$$\pi_{1i} = \beta_{10} + \beta_{11}*(SEX_i) + \beta_{12}*(ETH_i) + \beta_{13}*(FRL_i) + \beta_{14}*(ASD_i) + \beta_{15}*(TBI_i) + \beta_{16}*(EBD_i) + r_{1i}$$

$$\pi_{2i} = \beta_{20} + \beta_{21}*(SEX_i) + \beta_{22}*(ETH_i) + \beta_{23}*(FRL_i) + \beta_{24}*(ASD_i) + \beta_{25}*(TBI_i) + \beta_{26}*(EBD_i) + r_{2i}$$

The final piecewise model was:

Level-1:

$SCORE_{ti} = \pi_{0i} + \pi_{1i}*(LinearTime_{ti}) + \pi_{2i}*(InterceptChange_{ti}) + \pi_{3i}*(SlopeChange_{ti}) + e_{ti}$

Level-2:

$\pi_{0i} = \beta_{00} + \beta_{01}*(SEX_i) + \beta_{02}*(ETH_i) + \beta_{03}*(FRL_i) + \beta_{04}*(ASD_i) + \beta_{05}*(TBI_i) + \beta_{06}*(EBD_i) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}*(SEX_i) + \beta_{12}*(ETH_i) + \beta_{13}*(FRL_i) + \beta_{14}*(ASD_i) + \beta_{15}*(TBI_i) + \beta_{16}*(EBD_i) + r_{1i}$

$\pi_{2i} = \beta_{20} + \beta_{21}*(SEX_i) + \beta_{22}*(ETH_i) + \beta_{23}*(FRL_i) + \beta_{24}*(ASD_i) + \beta_{25}*(TBI_i) + \beta_{26}*(EBD_i) + r_{2i}$

$\pi_{3i} = \beta_{30} + \beta_{31}*(SEX_i) + \beta_{32}*(ETH_i) + \beta_{33}*(FRL_i) + \beta_{34}*(ASD_i) + \beta_{35}*(TBI_i) + \beta_{36}*(EBD_i) + r_{3i}$

In order to meet statistical model assumptions, data were screened in SPSS including analyses for collinearity, outliers, missing data, and normality of distribution. Variables chosen for analysis were checked for collinearity by calculating squared multiple correlations between each variable and all other variables. The highest correlations were between sex and disability status (r = .09) and between minority status and FRL (r = .28) All other predictor variables were correlated .04 or less. Disability status, sex, and transition type had very low correlations with math and reading scores (r = .001 to .13). Higher correlations existed between math and reading scores and minority status (r = .14 to .24) and FRL (r = .29 to .33). Year-to-year correlations for reading ranged from .53 to .80 and for math ranged from .62 to .82. The moderately strong correlations for scores from year to year were expected.

Outliers. Because students with ASD or TBI have been shown to have wide variability in achievement as described above, particular sensitivity to outliers was important. For all students, the number of studentized residuals over |3| for math at each grade level ranged from 202 to 285 and for reading ranged from 242 to 321; all were less than .003% of the total sample. Cook's *d* was calculated to determine the influence of outlying cases and was near 0, indicating that outlying scores would not unduly influence the statistical results.

Missing data. Data from the state database contained demographic characteristics each year achievement tests were reported. Values for the variables sex, ethnicity, and FRL were assigned for the first year those variables were reported. By assigning values this way, all students had entries for all demographic variables. Test scores were missing for some students; the percent of scores present are shown in Table 7 and 8. Students were retained in the math analyses if they had at least one score for math and in the reading analysis if they had at least one score for reading resulting in slightly different analytic samples for reading and math. An important strength of HLM is that growth trajectories can be estimated even when data are missing at some occasions. Estimation in HLM utilized full maximum likelihood (FML) in all analyses.

Table 7
Number and Percent of Reading Scores Present for Each Cohort

Number of scores present	Total sample		Cohort 1		Cohort 2		Cohort 3	
	n	%	*n*	%	*n*	%	*n*	%
1	11885	9.5	4531	11.4	3494	8.3	3860	9.0
2	9817	7.9	3763	9.4	3061	7.3	2993	6.9
3	9856	7.9	3481	8.7	3104	7.4	3271	7.6
4	11680	9.3	4376	11.0	3389	8.1	3915	9.1
5	57757	46.2	20144	50.5	14219	33.9	23394	54.3
6	23958	19.2	3556	8.9	14719	35.1	5683	13.2
Total	124953	100	39851	100	41986	100	43116	100

Table 8
Number and Percent of Mathematics Scores Present for Each Cohort

Number of scores present	Total sample		Cohort 1		Cohort 2		Cohort 3	
	n	%	*n*	%	*n*	%	*n*	%
1	12130	9.7	4624	11.5	3542	8.4	3964	9.1
2	9915	7.9	3814	9.5	3088	7.3	3013	7.0
3	9827	7.8	3455	8.6	3121	7.4	3251	7.5
4	11640	9.3	4351	10.8	3384	8.0	3905	9.0
5	57570	45.8	20207	50.4	13979	33.1	23384	53.9
6	24564	19.6	3661	9.1	15071	35.7	5832	13.5
Total	125646	100	40112	100	42185	100	43349	100

Univariate and multivariate normality of distributions. Skew, kurtosis, stem-and-leaf plots, and box-whisker plots were examined for each reading and math time point to assess distribution of variables. Variables at each time point were normally distributed.

CHAPTER III

RESULTS

Transition Relationships

To determine the relationships of transition time for the entire sample, unconditional piecewise models were run separately for reading and math. Initial intercept, slope, and change in slope at transition were significant although change in intercept at transition was not significant in the reading model. A second conditional model for reading added level-2 predictors for transition at Grade 6 and transition at Grade 7 (see Appendix C). Students with no transition were the reference category. The transition from elementary school was associated with reduced reading achievement for the entire sample as can be seen in Figure 1. The lowest pre-transition average growth trajectory was for students who would not transition to middle or junior high schools. Yet, those students had higher post-transition trajectories than either other group. Children who transitioned at Grade 6 had a negative changes in intercept, $\beta = -0.59$, $t(124{,}943) = -6.74$, $p < .001$ and in slope, $\beta = -0.31$, $t(124{,}943) = -5.52$, $p < .001$. Although students who transitioned in Grade 7 had a non-significant in change in intercept, they did have a negative change in slope, $\beta = -0.78$, $t(124{,}943) = -12.24$, $p < .001$.

The results for math indicated that students who transitioned at Grade 6 had negative changes in intercept $\beta = -1.02$, $t(125{,}643) = -11.00$, $p < .001$ and slope $\beta = -0.26$, $t(125{,}643) = -4.36$, $p < .001$. Mean scores for the transition groups are shown in Figure 2. Likewise, the children who transitioned at Grade 7 also had negative changes in intercept $\beta = -0.28$, $t(125{,}643) = -2.68$, $p = .007$ and slope $\beta = -0.72$, $t(125{,}643) = -10.66$, $p < .001$

as shown in Figure 2. Thus, in both reading and mathematics, students progressed at a slower pace after transition than before. Students who transitioned at Grade 7 exhibited the most negative slope change post-transition.

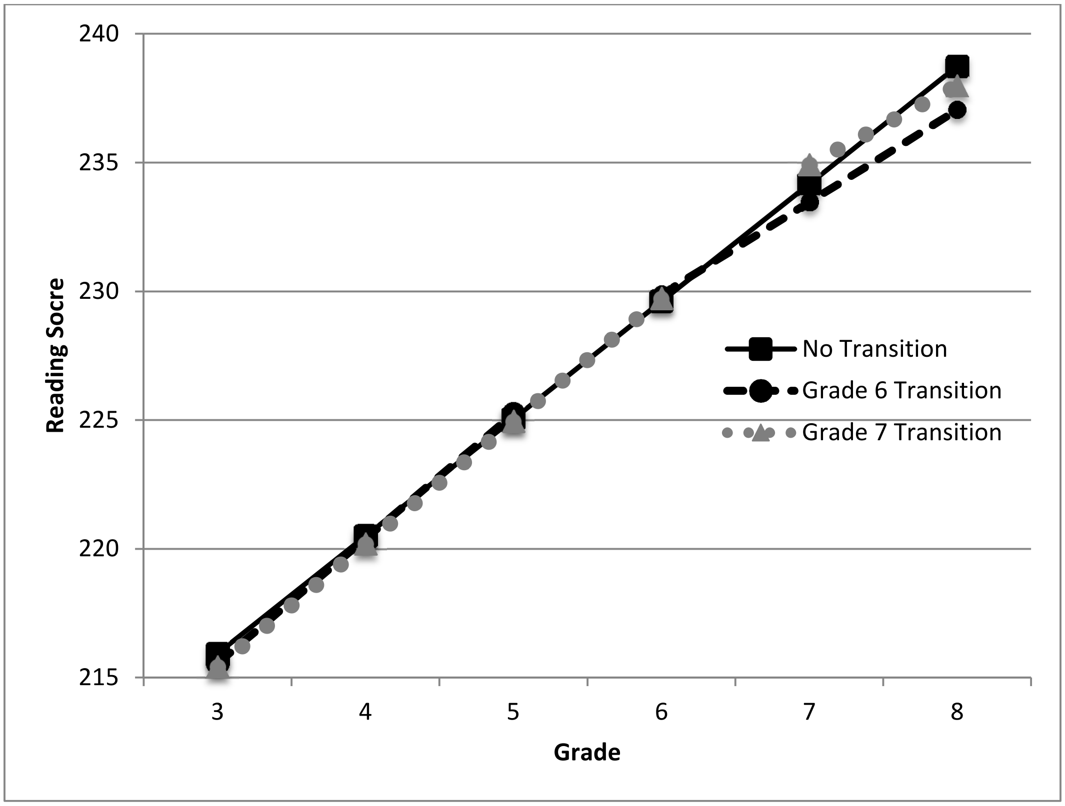

Figure 1. Reading achievement growth trajectories for students who transitioned at Grade 6, Grade 7, or had no transition.

Reading Achievement Growth

Observed mean scores for reading across grades were generally increasing with some deceleration in later grades, roughly consistent with a curvilinear form (see Appendix A). In Grade 3, SWoDs had the highest mean score (*M* = 215.03, *SD* = 10.85) followed by students with ASD (*M* = 208.67, *SD* = 16.63), TBI (*M* = 199.97, *SD* = 20.25), and EBD (*M* = 204.64, *SD* = 16.64). As expected, Grade 3 scores for all SWDs reflected substantially greater variability than SWoDs but all students' variability generally decreased over time (See Table 9). The mean scores for each year showed that students with each of the three disabilities progressed similarly, without overlaps, and in the same order.

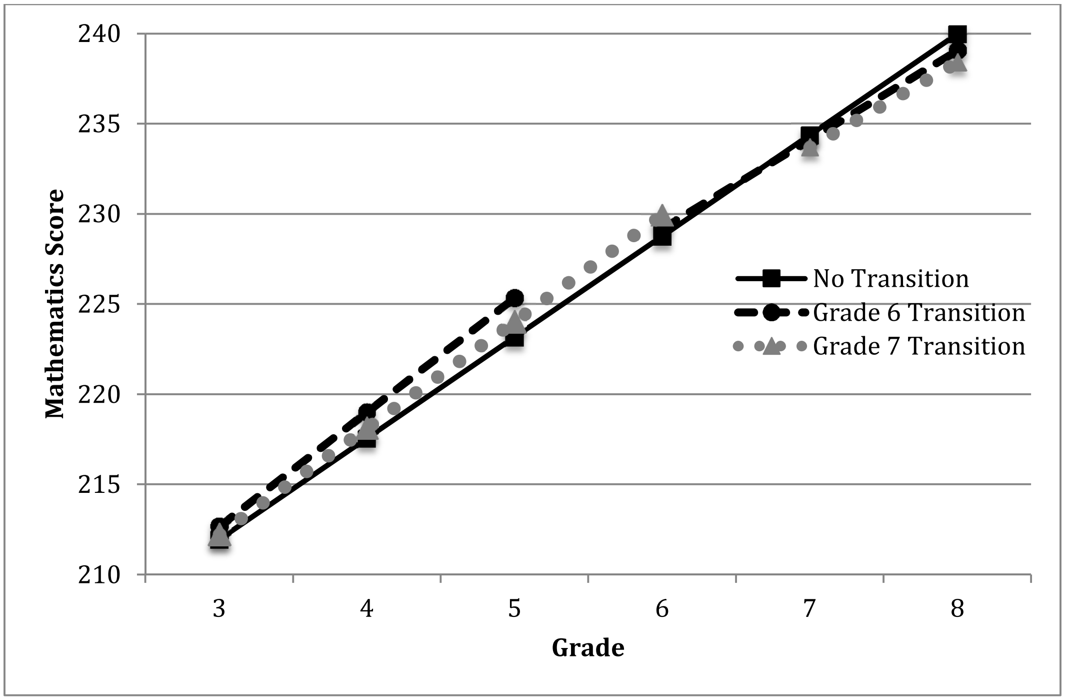

Figure 2. Mathematics achievement growth trajectories for students who transitioned at Grade 6, Grade 7, or had no transition.

Table 9

Observed Mean Reading Scale Scores and Standard Deviations by Grade for Students Without Disabilities, and Students with ASD, TBI, or EBD

	Grade					
Group	3	4	5	6	7	8
SWoDs	215.25	221.88	225.19	229.62	235.49	235.89
	(10.55)	(10.05)	(8.75)	(8.58)	(9.05)	(8.18)
ASD	210.01	216.79	219.68	224.97	230.34	231.56
	(12.40)	(11.95)	(10.85)	(10.57)	(10.48)	(9.53)
TBI	202.74	208.82	213.19	218.12	222.50	224.22
	(12.13)	(10.08)	(9.00)	(8.25)	(7.32)	(7.87)
EBD	206.14	213.78	216.92	221.17	226.57	227.36
	(12.11)	(10.90)	(10.40)	(9.88)	(9.81)	(9.47)

Note. SWoDs = students without disabilities; ASD = autism spectrum disorder; TBI = traumatic brain injury; EBD = emotional/behavioral disturbance.

Multilevel Growth Models in Reading

The first model estimated was an unconditional random effects model that estimated grand means and variance components. Next a linear longitudinal two-level model was applied. In comparison to the unconditional model, the linear longitudinal model resulted in a statistically significant improvement in model fit as evaluated by a deviance test, χ^2 (3) = 513760.85, $p < .001$. Application of a quadratic longitudinal model also resulted in a significant improvement in model fit over the linear model, $\chi^2(4)$ = 16364.06, $p < .001$. Because the primary focus of the study research questions was on the evaluation of changes in trajectory at transition, a piecewise model was fit that directly tested transitional changes. The piecewise model introduced a second intercept and slope beginning at the time of transition. Application of the piecewise model also produced a significant improvement over the linear model, $\chi^2(9)$ = 8233.10, $p < .001$. The quadratic and piecewise models resulted in very similar estimates in both the mathematics and reading models. Although the quadratic model had slightly better fit in both models, it only accounted for less than one percent of additional variance explained over the piecewise models. Because the piecewise models allowed more direct evaluation of the primary research questions addressing transition relationships, they are reported below for the remainder of the results. Details on quadratic models are presented in Appendix B.

After deciding to continue with the piecewise model, the next model applied included student demographic characteristics as additional level 2 predictors. This model was compared to the unconditional piecewise model, resulting in a statistically significant improvement in model fit, $\chi^2(12)$ = 20,617.07, $p < .001$. The three demographic characteristics were sex (dummy coded 0 = male, 1 = female), minority status (0 = white, 1 = minority), and FRL (0 = does not qualify, 1 = qualifies). As shown in Table 10, minority status and lower income were associated with both intercept and both growth parameters; sex showed associated with all but the pre-transition slope.

The final piecewise model showed a statistically significant improvement over the demographics only model, χ^2 (12) = 2,620.89, $p < .001$. As can be seen in Table 10, the random effects of parameters in this model were all statistically significant with the exception of Grade 6 intercepts. These results indicate that, other than Grade 6 intercepts, each model parameter varied significantly across students.

A graph of the mean trajectories by disability category is presented in Appendix A. The figure also lists the Oregon proficiency cutpoints to allow comparison of average student group performance to the state standard for federal NCLB accountability reporting. Students with ASD barely exceeded the minimum cutpoints whereas students with TBI or EBD never exceeded the minimum.

Although the demographic variables in the study were not central to the primary research questions, their inclusion in the final models allowed estimation of the unique variance attributed to the three disability categories separate from associations with students' sex, FRL status, and minority status. For reading, girls scored higher than boys on average at each grade level and the gap grew slightly over time. Minority students scored lower than their white peers at all grade levels but narrowed that gap during elementary school. Lower income students scored lower in Grade 3 and started to catch up during elementary school. However, their changes in intercept and slope were lower than their higher income peers.

Students with ASD. Students with ASD began Grade 3 with average scores lower than SWoDs (β = -7.30, *SE* = .48, $t(124,946) = -18.20$, $p < .001$). However, their linear growth was slightly higher than SWoDs (β = .48, *SE* = .12, $t(124,946) = 3.80$, $p < .001$). Effect sizes (Cohen's *d*) were calculated to aid in interpretation as shown in 110. Compared to SWoDs, students with ASD in Grade 3 had a medium effect size of .61 (see Table 11). Their gains in transition intercept and slope were small and not statistically significant, indicating that beyond growing faster than SWoDs over time, they had no change associated with the middle or junior high school transition. As with the estimates from each disability category, the variability was much higher for students with ASD compared to general education students.

Students with TBI. Initial average scores for students with TBI at the Grade 3 were significantly lower than SWoDs (β = -15.48, *SE* = 2.82, $t(124,946) = -5.50$, $p < .001$ and as can be seen in Table 11, reflected a large effect size ($d = 1.41$). Although TBI students had the highest coefficient for the linear growth parameter (β = 1.03, *SE* = .84, $t(124,946) = 1.23$, $p = .22$, $d = .33$) of all demographic and exceptionality categories, the high standard error prevented a statistically significant test of the difference in linear growth. At transition, the change in intercept and change in slope were also not statistically significant, so as with students with ASD, the post-elementary transition was not statistically different for students with TBI than their general education peers. Individual student variability can be seen in Figure 3 which displays model-based results of 15 randomly selected growth trajectories for students with TBI with reference

TABLE 10

Fixed and Random Effects Piecewise Longitudinal HLM Regression Models for Reading, Grades 3 to 8

	Demographics				Demographics and Exceptionalities			
	Intercept	Slope	Δ Intercept	Δ Slope	Intercept	Slope	Δ Intercept	Δ Slope
Mean β00	219.65**	4.24**	0.45**	-1.35**	219.99**	4.22**	0.45**	-1.34**
	(0.06)	(0.02)	(0.04)	(0.03)	(0.06)	(0.02)	(0.04)	(0.03)
Sex β01	0.88**	0.02	0.26**	0.35**	0.59**	0.04*	0.26**	0.35**
	(0.06)	(0.02)	(0.04)	(0.03)	(0.06)	(0.02)	(0.04)	(0.03)
Minority β02	-4.34**	0.46**	-0.38**	-0.10*	-4.47**	0.47**	-0.39**	-0.10*
	(0.07)	(0.02)	(0.05)	(0.03)	(0.07)	(0.02)	(0.05)	(0.03)
FRL β03	-5.67**	0.38**	-0.43**	-0.10*	-5.54**	0.37**	-0.43**	-0.09*
	(0.07)	(0.02)	(0.05)	(0.03)	(0.07)	(0.02)	(0.05)	(0.03)
ASD β04					-7.30**	0.48**	0.14	0.01
					(0.40)	(0.12)	(0.23)	(0.16)
TBI β05					-15.48**	1.03	-0.40	0.11
					(2.82)	(0.84)	(1.20)	(1.00)
EBD β06					-9.30**	0.44*	-0.10	-0.29
					(0.47)	(0.16)	(0.31)	(0.21)

	Demographics				Demographics and Exceptionalities			
Random Effect	Intercept	Slope	Δ Intercept	Δ Slope	Intercept	Slope	Δ Intercept	Δ Slope
Variance Component	89.15**	2.38**	0.93	0.86**	87.36**	2.37**	0.92	0.86**
Residual	19.17				19.16			
Pseudo R2	.152	.035	.100	-.030	.169	.039	.102	-.024
Model df	72131				72128			
Deviance χ^2	20,613.07				2620.89			
(df, p-value)	(12, < .001)				(12, < .001)			

Table 11
Effects Sizes of Observed Reading and Mathematics Scores for Students with ASD, TBI, or EBD

Category	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
	Reading					
ASD	0.61	0.54	0.62	0.54	0.56	0.52
TBI	1.41	1.48	1.35	1.32	1.42	1.41
EBD	0.98	0.88	0.93	0.97	0.97	1.03
	Math					
ASD	0.53	0.56	0.61	0.57	0.51	0.49
TBI	1.15	1.30	1.21	1.04	1.05	1.36
EBD	0.81	0.86	0.97	1.09	1.04	1.12

Note. Effect sizes compared the disability category to SWoDs and were calculated using the pooled standard deviations from the grades described.

lines showing the mean trajectories for SWoDs and the mean for all students with TBI. The figure illustrates the variability in scores for the students with TBI, as well as showing that some students actually had accelerating growth after the middle school transition as was indicated by the positive but non-significant coefficient of 0.11.

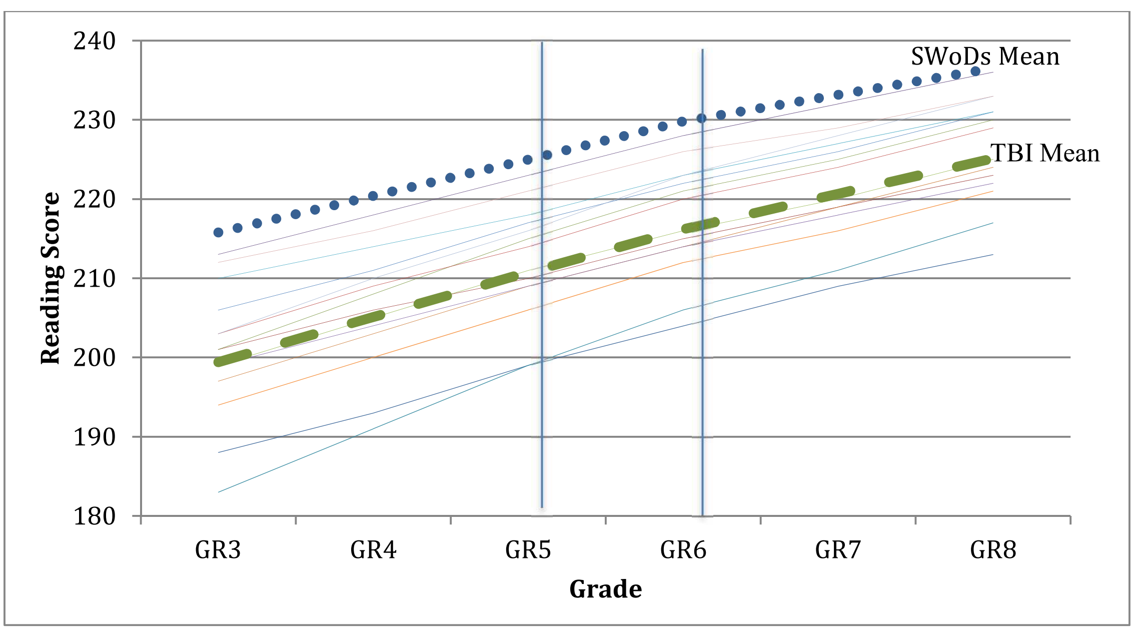

Figure 3. Mean reading growth trajectories of students without disabilities (SWoDs), with traumatic brain injury (TBI), and 15 randomly selected students with TBI.

Students with EBD. The growth trajectories for students with EBD were similar to students with ASD. However, students with EBD started Grade 3 lower than students with ASD and significantly lower than general education students (β = -9.30, *SE* = .47, $t(124{,}946) = -19.793$, $p < .001$, $d = .98$). The initial slope for EBD students was significantly greater than the slope for general education students (β = .44, *SE* = .16, $t(124{,}946) = 2.82$, $p = .005$, $d = .97$). However, the changes in intercept and slope were not statistically significant indicating that the post-transition growth trajectories for these students were not different than SWoDs. However, the modeled means showed these students' Grade 3 scores were above the cut score for "meets proficiency" but by 5th grade, they were lower than the proficiency cutpoint and that gap increased over time (see Figure 1).

Mathematics Achievement Growth

The observed mean scores for math across grades were similar to scores in reading, generally increasing with some deceleration in later grades (see Table 12). Initial mean scores for each disability group maintained the same hierarchy as reading. SWoDs scored the highest (*M* = 212.08, *SD* = 9.35) followed by students with ASD (*M* = 207.02, *SD* = 12.26), TBI (*M* = 201.22, *SD* = 11.14), and EBD (*M* = 204.41, *SD* = 10.92). At Grades 6 and 7, students with TBI had approximately the same mean scores as students with EBD but dropped below them at Grade 8. The other groups demonstrated roughly parallel growth for all six grades. Unlike reading, the math variability remained relatively constant over time as shown in Table 12, with the exception of students with TBI whose standard deviations were higher in Grades 3 and 6 than in their other grades.

Multilevel Growth Models in Mathematics

An unconditional random effects model for math estimated grand means and variance components. Then a linear growth model with random effects was applied. The model improvement was statistically significant, χ^2 (4) = 596,107.14, $p < .001$. As in the reading model development process, the linear model was followed by a quadratic longitudinal model, which also showed an improvement in model fit over the linear model, χ^2 (4) = 21,625, $p < .001$. The final unconditional model was a piecewise model with a separate intercept and slope beginning at the time of transition. The piecewise model also showed a significant improvement over the linear model, χ^2 (9) = 13,413.89 $p < .001$. As with reading, the mathematics quadratic model showed slightly better

Table 12

Observed Mean Math Scale Scores and Standard Deviations by Grade for Students Without Disabilities, and Students with ASD, TBI, or EBD

	Grade					
Group	3	4	5	6	7	8
SWoDs	212.08	219.48	226.30	228.99	235.59	238.11
	(9.35)	(9.60)	(9.53)	(9.66)	(9.34)	(10.25)
ASD	207.02	214.01	220.46	223.41	230.80	232.99
	(12.26)	(12.38)	(11.82)	(12.56)	(11.37)	(12.52)
TBI	201.22	206.87	214.62	218.81	225.66	224.00
	(11.14)	(9.61)	(9.15)	(10.84)	(7.29)	(8.74)
EBD	204.41	211.14	216.91	218.32	225.80	226.45
	(10.92)	(10.73)	(10.00)	(10.44)	(9.27)	(10.55)

Note. SWoDs = students without disabilities; ASD = autism spectrum disorder; TBI = traumatic brain injury; EBD = emotional/behavioral disturbance.

fit than the piecewise model, but accounted for less than one percent additional variance explained over the piecewise model. Appendix B provides more information on the quadratic model. The piecewise model was used for further analyses to more specifically answer the research questions.

The next model applied student demographic variables (sex, minority status, and FRL status) to the unconditional piecewise model, resulting in a statistically significant improvement in fit, χ^2 (12) = 15,681.59, p < .001. Finally, the three disability categories were added to the piecewise growth model with demographic variables. The final model also showed a significant improvement in fit over the demographics-only model, χ^2 (12) = 2,932.23 *p* < .001). Similar to the reading model, students who did not experience a transition had pre-transition scores lower than the transitioning students, yet due to the changes in intercept and slope for transitioning students, students who did not transition had higher post-transition mathematics scores as can be seen in Appendix A.

In the final model, demographic variables accounted for changes in nearly all intercepts and slopes. Although the means for girls were lower than boys in Grade 3, their slopes in elementary school showed a reduction in that gap. Minority students progressed a little faster than white students in elementary school even though minority students started on average, about 3 points lower in third grade. Their change in intercept was less depressed than whites, and their growth after the transition to middle school was slower than their white peers. Lower income students scored consistently lower until middle school, when the gap was slightly reduced. Results for the mathematics final piecewise model are presented in Table 13.

Students with ASD. Students with ASD scored significantly lower (β = -6.75, *SE* = .31, *t*(125,639) = -21.63, *p* < .001) than SWoDs in Grade 3, showing a medium effect size (*d* = .53). Their linear growth, unlike reading, was not significantly different than SWoDs. However, they gained more in both their change in intercept (β = 0.66, *SE* = .26, *t*(125,639) = 2.53, *p* = .011) and change in slope (β = .47, *SE* = .17, *t*(125,639) = 2.73, *p*

= .006) than SWoDs, demonstrating that even though starting lower than their peers without disabilities, they made more progress post-transition. Modeled mean scores were consistently above the minimum proficiency cutpoint, as can be seen in Figure 3.

Students with TBI. In Grade 3, students with TBI scored lower (β = -11.77, *SE* = 1.35, *t*(125,639) = -8.72, *p* < .001) than SWoDs, the lowest of all groups and exhibited a large effect size (*d* = 1.15). Figure 3 illustrates that the modeled mean scores for students with TBI were about 5 points lower than SWoDs, and consistently below the Oregon proficiency cutpoint. Although their linear slope and change in intercept increased, and their change in slope decreased, none were statistically significant, indicating that math scores were not associated with the post-elementary transition.

However, as with reading, the coefficients were substantial and large standard errors may help explain the lack of significance. Modeled scores are presented from a random sample of 15 students with TBI along with the mean from SWoDs and the mean of students with TBI in Figure 4. Although the reading scores showed a positive, albeit not statistically significant change of slope in reading, students demonstrated reduced (also non-significant) change in slope for math. However, Figure 4 illustrates not only substantial variation in slopes, but also the change in slopes may not be well predicted by elementary performance. So even though the change in slope was not significant, the coefficient was large (β = -1.18, *SE* = 0.75, *t*(125,639) = -1.57, *p* = .12).

Students with EBD. Although students with EBD initially scored lower than SWoDs (β = -7.34, *SE* = .32, *t*(125,639) = -22.98, *p* < .001, *d* = .81) and their linear trajectory was lower (β = -1.04, *SE* = .12, *t*(125,639) = -8.54, *p* < .001), their change in intercept was smaller (β = 1.22, *SE* = .31, *t*(125,639) = 3.88, *p* < .001) than SWoDs.

Their change in growth rate was not significant, showing that after the initial boost in scores at transition, students with EBD progressed at a rate similar to SWoDs after transitioning. As can be seen in Figure 3, the modeled mean scores for students with EBD were lower than students with ASD, much lower than SWoDs, and after the Grade 3 assessment, stayed consistently below the Oregon proficiency cutpoints.

TABLE 13

Fixed and Random Effects Piecewise Longitudinal HLM Regression Models for Mathematics, Grades 3 to 8

	Demographics				Exceptionalities			
	Intercept	Slope	Δ Intercept	Δ Slope	Intercept	Slope	Δ Intercept	Δ Slope
Mean β00	216.52**	5.92**	-2.11**	-1.25**	216.83**	5.94**	-2.14**	-1.27**
	(0.05)	(0.02)	(0.05)	(0.03)	(0.05)	(0.02)	(0.05)	(0.03)
Sex β01	-1.38**	0.22**	0.08	0.03	-1.63**	0.20**	0.12*	0.05
	(0.06)	(0.02)	(0.05)	(0.03)	(0.06)	(0.02)	(0.05)	(0.03)
Minority β02	-2.97**	0.54**	-0.50**	-0.31**	-3.09**	0.53**	-0.49**	-0.31**
	(0.06)	(0.02)	(0.06)	(0.04)	(0.06)	(0.02)	(0.06)	(0.04)
FRL β03	-4.63**	-0.15**	-0.12*	0.08*	-4.53**	-0.13**	-0.14*	0.07*
	(0.06)	(0.02)	(0.05)	(0.04)	(0.06)	(0.02)	(0.05)	(0.04)
ASD β04					-6.75**	-0.17	0.65*	0.47*
					(0.31)	(0.10)	(0.26)	(0.17)
TBI β05					-11.77**	0.16	1.54	-1.18
					(1.35)	(0.47)	(1.40)	(0.75)
EBD β06					-7.34**	-1.04**	1.22**	0.39
					(0.32)	(0.12)	(0.31)	(0.21)
Random Effects	Intercept	Slope	Δ Intercept	Δ Slope	Intercept	Slope	Δ Intercept	Δ Slope
Variance Component	64.28**	2.74**	5.41**	2.13*	63.01**	2.72**	5.33**	2.10*
Residual	20.52				20.52			
Pseudo R^2	.134	.012	-.028	-.004	.151	.020	-.012	.007
Model df	72469.00				72466.00			
Deviance χ^2	15681.59				2932.23			
df, p-value	(12, <.001)				(12, <.001)			

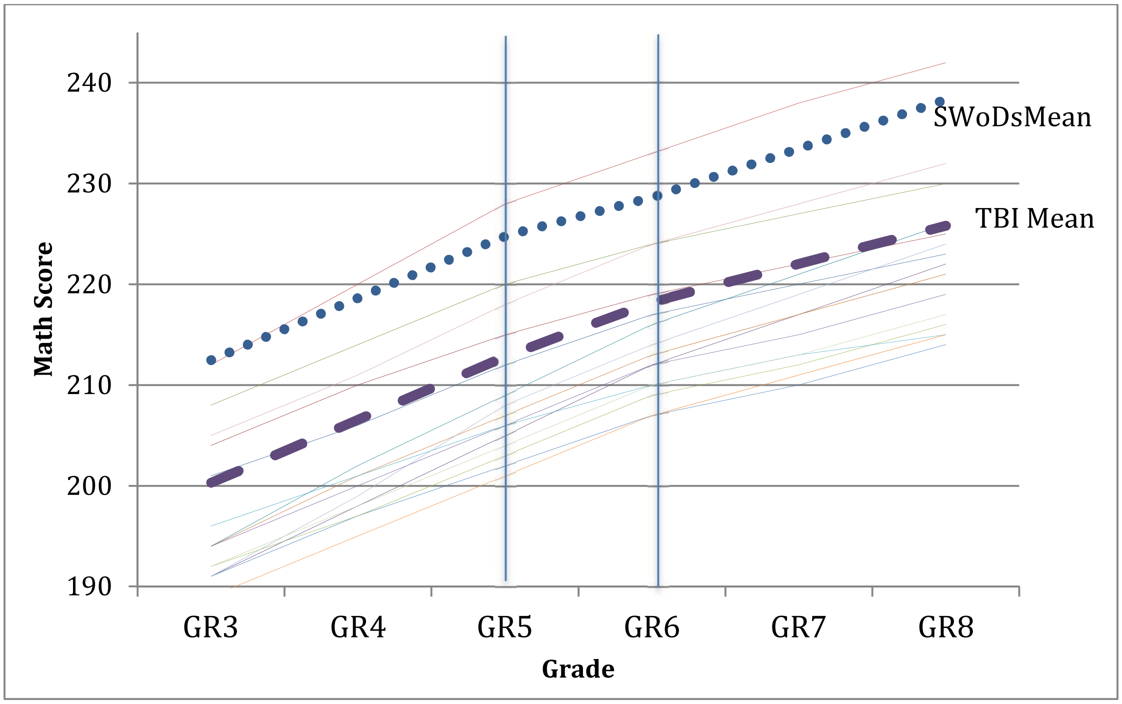

Figure 4. Mean mathematics growth trajectories of students without disabilities and students with TBI, and modeled trajectories of 15 randomly selected students with TBI.

CHAPTER IV

DISCUSSION

This study augmented the sparse research on the longitudinal growth of academic achievement for students with three understudied disabilities, ASD, TBI, and EBD, especially in regard to their growth over the elementary-to-middle school transition period. The results were consistent with other achievement growth studies in showing that most students experienced steady growth in reading and math between Grades 3 and 8 with some deceleration in later grades (Morgan et al., 2011; Schulte et al., 2001; Shin et al., 2013; Stevens et al., 2014; Wei et al., 2011; Wei et al., 2013). In addition, this study provided a more detailed analysis by examining student growth in three specific exceptionality groups, (ASD, TBI, or EBD) and estimated their growth trajectories on the state achievement test scores that are used for federal accountability reporting.

Transition from Elementary School

Elementary achievement growth trajectories for reading and mathematics were similar and positive for all students prior to transition. At Grade 6, however, different patterns emerged for reading and math, as well as transition time. The change in intercept at transition was negative for both transition times in reading (and the most severe for students who transitioned in 6th grade), whereas only students who transitioned at Grade 6 experienced a similar negative change in math. The change in slope after transition was lower for both groups in both reading and math, about one and two points per year, respectively, indicating that growth after transition was lower than before, whether in Grade 6 or 7. Unlike the change in intercept, students who transitioned in 7th

grade had the most negative change in slope. These results are compatible with previous research that has shown better academic outcomes for students who do not experience a sixth grade transition (Alspaugh, 1998; Bedard & Do, 2005; Chung et al., 1998; Cook et al., 2008; Holas & Huston, 2012; Weiss & Kipnes, 2006) These findings provide a small amount of support for the postulation that transition, be it in 6th or 7th grade, is negatively associated with achievement for students on the whole. Previous longitudinal research that modeled growth as a quadratic form has not been able to show this relationship.

Students with ASD. In this study, at every grade level, students with ASD scored above the minimum state cut score for "meets proficiency", lower than SWoDs, and above students with TBI or EBD for both reading and math as can be seen in Figures 1 and 3. These results support past research examining reading comprehension achievement (Minshew et al., 1994; Nation et al., 2006; Newman et al., 2007) and math achievement (Mayes & Calhoun, 2003b). The transition to middle school for students with ASD appears related to achievement very similarly to general education students. For reading, post-transition intercept and middle school growth were not significantly different than SWoDs, thereby sustaining the reading achievement gap, similar to the results reported by Wei, et al (2011).

In contrast, mathematics growth in elementary school remained parallel to SWoDs until transition, when positive changes in both intercept and slope began to reduce the achievement gap. This finding is similar to Stevens, et al. (2014) whose quadratic estimations also showed a reduction in the achievement gap for students with ASD. However, this finding conflicts with other research that has found lower growth trajectories and similar deceleration as students with learning disabilities for both calculation and applied problems (Wei et al., 2013).

The fact that students scored lower in various aspects of reading has been well documented. What this study added to the literature is that for reading, students with ASD showed accelerated gains over time during the elementary school years. In math, that improvement came only after transition.

Students with TBI. Scores of students with TBI in both reading and math were 12 to 15 scale score points lower at Grade 3 than SWoDs, the lowest of any group, and never reached the proficiency cutpoints at any grade. No statistically significant differences were found in slope or changes in intercept or slope in comparison to general education students. This is likely due to the small number of students in the TBI group, as well as high variability in scores for this group. Even so, the medium to large effect sizes shown in Table 9 suggest that the elementary reading growth trajectories and change in intercept at Grade 6 as well as the mathematics changes in intercept and slope may represent important differences if they could be established through more powerful statistical tests. Math growth was parallel to SWoDs prior to transition.

Students with EBD. Compared to their general education peers, modeled average reading and math scores for students with EBD were lower at every grade level, consistent with past research (Gronna et al., 1998; Reid et al., 2004; Stevens et al., 2014; Wagner, 1995). Their scores were below SWoDs and students with ASD and above students with TBI. Although third grade scores were at or above the minimum proficiency cutpoint, students quickly fell below the cutpoint in subsequent years and never reduced the gap with general education students.

This study revealed very different results in reading and math longitudinal growth trajectories for students with EBD. Reading results showed substantial gains compared to SWoDs until transition, when the trajectories became parallel. This pattern is congruent with Gronna (1998) but opposite to that found by Wei (2011) who compared students with EBD to students with LD. The results for math, however, showed much lower gains compared to SWoDs in elementary school, then like students with ASD, improved growth post-transition. This finding is consistent with some previous research (Wei et al., 2013) but different than others (Gronna et al., 1998; Stevens et al., 2014; Wagner, 1995)).

Limitations

Limitations of this study include the small number of students with TBI. Even though the number included in the present study is small, the information gained will add to general understanding of these students. Data for this study were from a single northwest state. The majority of racial or ethnic minority students was primarily Hispanic. Other states with different student composition might have different results. The lack of specific information used in other studies about students with ASD or TBI (e.g., intelligence test scores, severity of injury, age at injury) prohibit direct comparisons to much of the existing research. In addition, the movement in and out of special education categories and the attrition and mobility of students from school to school was not specifically modeled in this study. Although the proportion of those students was small, those factors may have affected analytic results. Lastly, results from this study were based on one state's achievement test. The use of a single outcome measure may lead to results that are more highly affected by the psychometric properties of the measure. Measurement concerns are similar to those in other achievement studies, for example, the dependence on reading skills for the mathematics assessment, ceiling or floor effects (although Oregon's computer-adaptive testing format reduces those effects), or inability to include the most impaired students because they took a test that was not well-linked to the regular test. Other state accountability tests or assessment programs such as the NAEP might produce different results.

Implications

While in elementary school, students with ASD would benefit from attention to interventions know to be effective in closing the reading achievement gap to build on earlier success. However, in middle school, these students might be best served by identifying strategies that reduce the deceleration in academic achievement noted in numerous studies. For math, these results indicated that, opposite to reading, more attention should be focused in reducing the achievement gap in elementary school to help the students thereby make the most of the growth already being demonstrated in middle school. Resources for academic and behavioral strategies for those working with students with ASD (as well as students with TBI or EBD) are available (Kanne, Grissom, & Farmer, 2010; Kauffman & Hallahan, 2011).

Implications for practice for students with TBI include concentrating on growth in reading from Grades 3 to 5 to build on the momentum already established that appears unhampered by the middle school transition. In math, however, the large negative coefficient suggests concentrating on reducing that deficit to prevent increasing the achievement gap. Specific recommendations have been identified elsewhere for working with students with TBI; see, for example, (Kanne et al., 2010; Kauffman & Hallahan, 2011; Ylvisaker et al., 2001).

It was notable that had students with EBD sustained their Grade 3-5 trajectories without the post-transition deceleration, they would likely have met the minimum cut scores in both reading and math by Grade 8. Therefore, if teachers concentrate on maintaining the elementary trajectory through middle school, many students with EBD might be able to reach the state proficiency cut score in both reading and math. As described in self determination theory, the psychological need for autonomy appears to be of central importance to academic motivation for students with EBD (Deci et al., 1992) and can be reinforced by autonomy-enhancing strategies such as fostering relevance, providing choice, and allowing criticism (Assor, Kaplan, & Roth, 2002).

Summary and Conclusion

The SWoDs in this study showed a similar deceleration in both reading and math achievement found by other researchers. Even though other researchers found growth to be quadratic, there is no indication any of them considered a piecewise growth model. The analyses in this report showed that the quadratic form provided only slightly better fit statistics than the piecewise form and that valuable information about the transition between elementary and middle school was better illustrated by the piecewise specification. The use of a piecewise model, with the second piece beginning after the transition from elementary school, showed that general education students demonstrated a strong linear growth pattern in the early grades that was later diminished by a lower intercept than if the linear pattern continued. In addition, they had a slower growth trajectory post-transition

With those relationships clarified, this study provides a little support for the conclusions of others that the transition to middle school or junior high itself might be problematic for students in general. This is consistent, too, with the psychological needs of competence, autonomy, and relatedness outlined in self-determination theory. NCLB has focused attention on closing the achievement gap for students in marginalized groups, including students with disabilities. Students in this study showed a post-transition deceleration of their reading and math achievement growth albeit with somewhat different patterns for each disability category. Strong reading and mathematics growth in elementary school for students in each disability category was followed by diminished growth after the transition, (except for students with ASD or EBD). These results showed a sustained or widening achievement gap, in direct contrast to the NCLB goals.

Because this is the first study of its kind to examine the relationships of transition on academic growth trajectories for students with ASD, TBI, or EBD, it presents a starting point for further research, replication, and inclusion of students from other diverse backgrounds. In addition, testing the interaction between transition points and disability categories would augment our knowledge about differences related to transition for each specific category. Future research would further our understanding of achievement growth of students with disabilities by modeling other disability categories in a similar way.

This study added to the literature by providing evidence of achievement growth in reading and math for Oregon students without an identified disability or with ASD, TBI, or EBD, three disability categories for which there is little longitudinal achievement growth information. An additional strength of this study was that it provides evidence based on the statewide achievement tests that are used for accountability for NCLB. Furthermore, evidence was provided that supports prior research on the slowing of growth, specifically at the point of transition out of elementary school, indicating special attention be paid to students with ASD, TBI, or EBD as they navigate a challenging school change at a vulnerable developmental period.

APPENDIX A

MODELED TRAJECTORIES BY DISABILITY

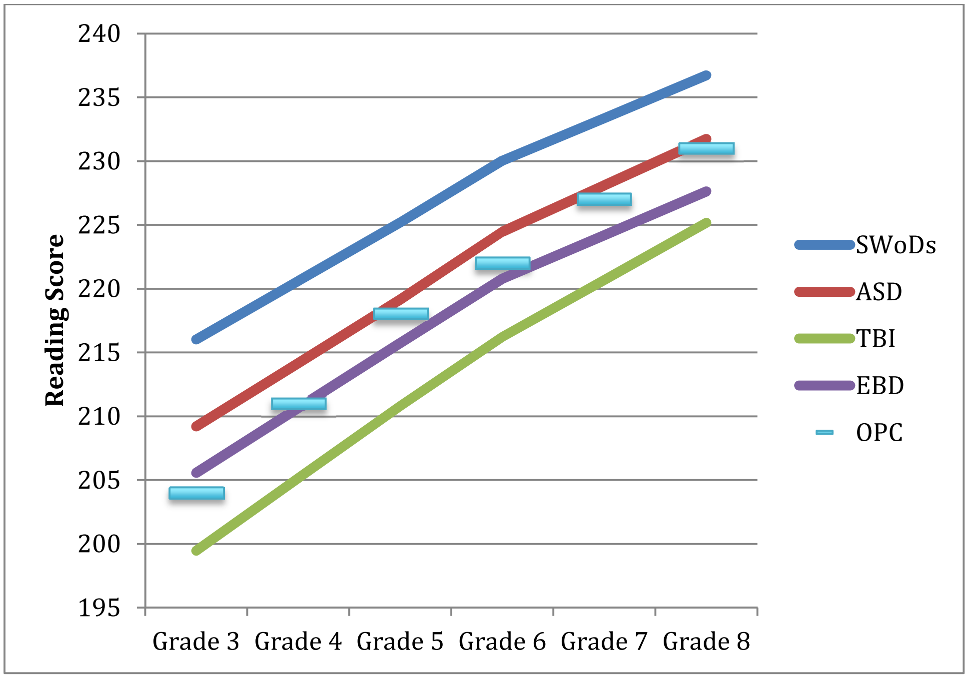

Figure A1. Reading growth trajectories of students without disabilities (SWoDs), with (ASD), (TBI), or (EBD). OPC = Oregon proficiency cutpoint.

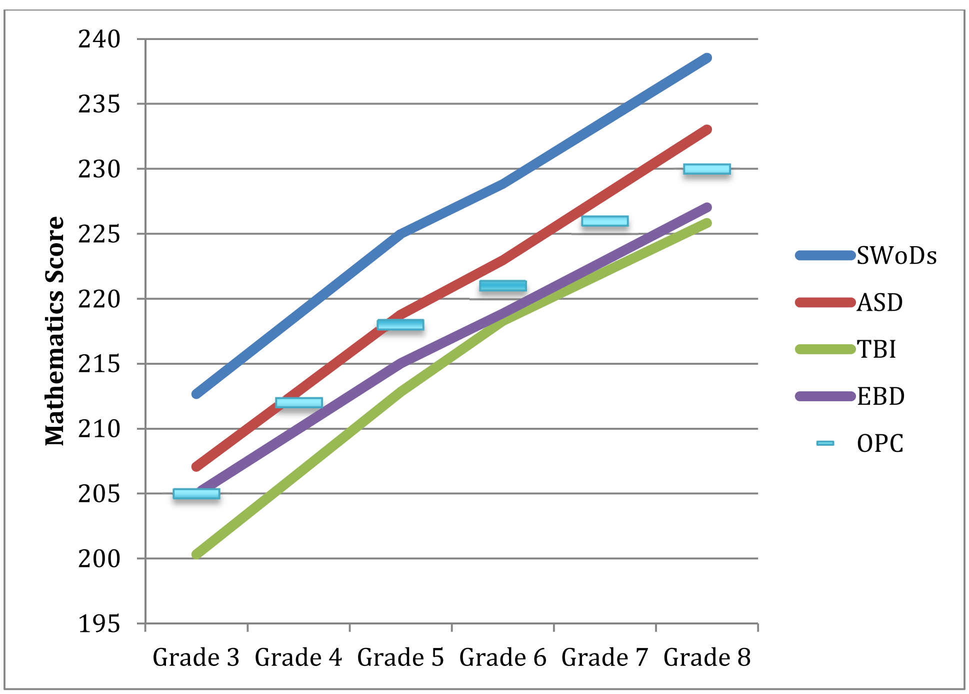

Figure A2. Mathematics growth trajectories of students without disabilities (SWoDs), (ASD), (TBI), or (EBD). OPC = Oregon proficiency cutpoint.

APPENDIX B

FIXED AND RANDOM EFFECTS QUADRATIC HLM REGRESSION MODELS

Fixed and Random Effects Quadratic Longitudinal HLM Regression Models for Reading and Math, Grades 3 to 8

	Reading			Mathematics		
	Intercept	Linear	Quadratic	Intercept	Linear	Quadratic
Mean β00	218.96**	5.77**	-0.36**	216.11**	7.17**	-0.42**
	(0.06)	(0.03)	(0.01)	(0.05)	(0.03)	(0.01)
Sex β01	0.75**	-0.23**	0.08**	-1.61**	0.16**	0.01*
	(0.06)	(0.03)	(0.01)	(0.06)	(0.03)	(0.01)
Minority β02	-4.47**	0.52**	-0.04**	-3.08**	0.61**	-0.06**
	(0.07)	(0.04)	(0.01)	(0.06)	(0.04)	(0.01)
FRL β03	-5.44**	0.28**	-0.01**	-4.45**	0.24**	0.02*
	(0.07)	(0.03)	(0.01)	(0.06)	(0.03)	(0.01)
ASD β04	-7.27**	0.45*	0.01	-6.68**	-0.40*	0.11**
	(0.43)	(0.22)	(0.03)	(0.32)	(0.17)	(0.03)
TBI β05	-15.7**	1.41	-0.11	-12.03**	0.80	-0.12
	(2.98)	(1.34)	(0.20)	(1.46)	(0.85)	(0.15)
EBD β06	-9.88**	1.20**	-0.17**	-7.68**	-7.74**	0.03
	(0.53)	(0.29)	(0.05)	(0.34)	(0.21)	(0.04)
Random Effect	Intercept	Linear	Quadratic	Intercept	Linear	Quadratic
Variance Component	90.27	5.11	0.06	63.46	3.88	0.09
Residual	18.77			20.51		
Pseudo R^2	.148	.027	.017	.163	.015	-.001
	103,244			103,594		
Deviance χ^2	8,391.64			8236.34		
(df, p-value)	(11, < .001)			(11, < .001)		

Note. Deviance and Pseudo R^2 compare the full quadratic model to the quadratic unconditional model.

APPENDIX C

TRANSITION MODELS

Fixed and Random Effects Longitudinal HLM Regression Models for Reading and School Transition

Fixed effects	Unconditional				Transition			
	Intercept	Slope	Δ Intercept	Δ Slope	Intercept	Slope	Δ Intercept	Δ Slope
No Transition	215.58**	4.79**	0.00	-1.32**	215.93**	4.56**	0.39**	-0.93**
	.03	.01	.02	.02	(.11)	(.04)	(.08)	(.05)
Transition at 6th					-0.36*	0.28**	-0.59**	-0.31**
					(.11)	(.04)	(.09)	(.06)
Transition at 7th					-0.51**	0.21**	0.04	-0.78**
					(.13)	(.05)	(.10)	(.06)
Random effects								
Variance component	106.82**	3.42**	2.00	1.67**	106.83**	3.42**	2.03	1.68**
Residual	18.87				18.84			
Pseudo-R2	-	-	-	-	<.001	-.002	<.001	-.004
Model df	87,029				87,027			
ΔDeviance, χ^2 (df, p-value)	-				482.44	(8, < .001)		

Fixed and Random Effects Longitudinal HLM Regression Models for Mathematics and School Transition

Fixed effects	Unconditional				Transition			
	Intercept	Slope	Δ Intercept	Δ Slope	Intercept	Slope	Δ Intercept	Δ Slope
No Transition	211.55**	7.14**	-3.99**	-2.25**	211.26**	6.75**	-3.24**	-1.90**
	(.03)	(.01)	(.03)	(.02)	(.09)	(.04)	(.09)	(.06)
Transition at 6th					0.33**	0.53**	-1.02**	-0.26**
					(.10)	(.04)	(.09)	(.06)
Transition at 7th					0.36**	0.20**	-0.28*	-0.73**
					(.11)	(.05)	(.10)	(.07)
Random effects								
Variance component	74.30**	3.13**	5.38**	4.03**	74.29**	3.10**	5.22**	3.97**
Residual	19.54				19.54			
Pseudo-R2	-	-	-	-	<.001	.011	.028	.014
Model df	87,442				87,440			
ΔDeviance, $\chi 2$ (df, p-value)	-				1136.25 (8, < .001)			

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